



P82952700.doc

---

(12) **UK Patent** (19) **GB** (11) **2 381 019** (13) **B**

---

(45) Date of publication: **29.12.2004**

---

(54) Title of the invention: **Apparatus and method for isolation of subterranean zones**

(51) Int Cl<sup>7</sup>: **E21B 43/10 29/00 33/12 33/124 // E21B 43/12 43/14**

(21) Application No: **0219757.2**

(22) Date of Filing: **23.08.2002**

(30) Priority Data:  
(31) **09981916** (32) **18.10.2001** (33) **US**

(60) Parent of Application No(s)  
**0422893.8** under Section 15(4) of the Patents Act 1977

(43) Date A Publication: **23.04.2003**

(52) UK CL (Edition W):  
**E1F FKF FLA FLW FMU**

(56) Documents Cited:  
**GB 2370301 A GB 2348657 A**  
**GB 2344606 A GB 2343691 A**  
**EP 1152120 A US 20020148612 A1**  
**US 20020066576 A1**

(58) Field of Search:  
As for published application 2381019 A viz:  
UK CL (Edition V) **E1F FKA FKF FLA FLW FMU**  
INT CL<sup>7</sup> **E21B 29/00 33/00 33/12 33/122 33/124 43/10 43/12 43/14 43/16**  
Other: Online: **EPODOC, JAPIO, WPI, TXTEP, TXTGB, TXTUS, TXTWO.**  
updated as appropriate

(72) Inventor(s):  
**Robert Lance Cook**  
**Michael L Bullock**

(73) Proprietor(s):  
**Enventure Global Technology**  
**(Incorporated in USA - Delaware)**  
**16200 A Park Row, Houston, Texas 77084,**  
**United States of America**

(74) Agent and/or Address for Service:  
**Haseltine Lake & Co**  
**Redcliff Quay, 120 Redcliff Street,**  
**BRISTOL, BS1 6HU, United Kingdom**

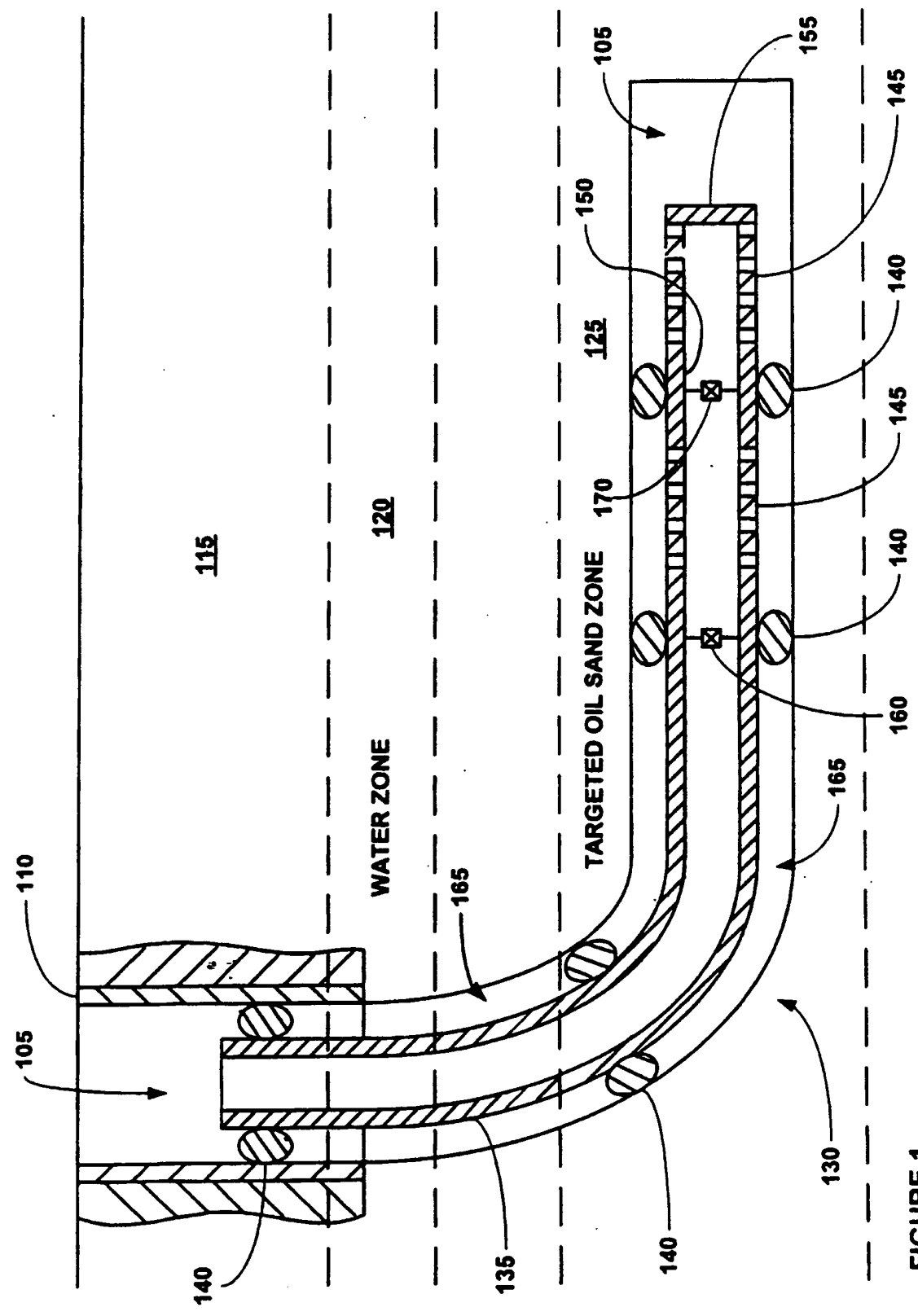


FIGURE 1

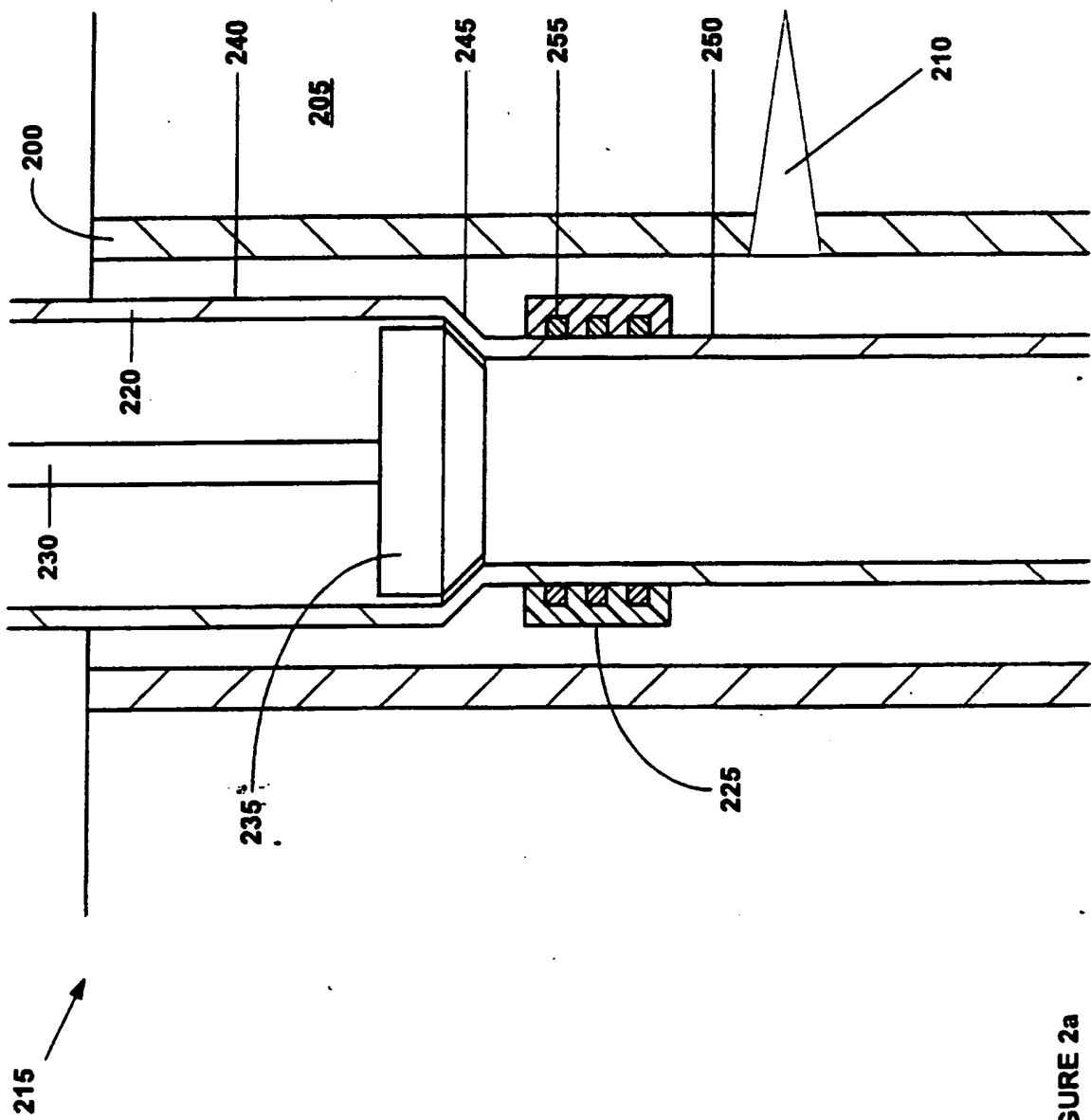
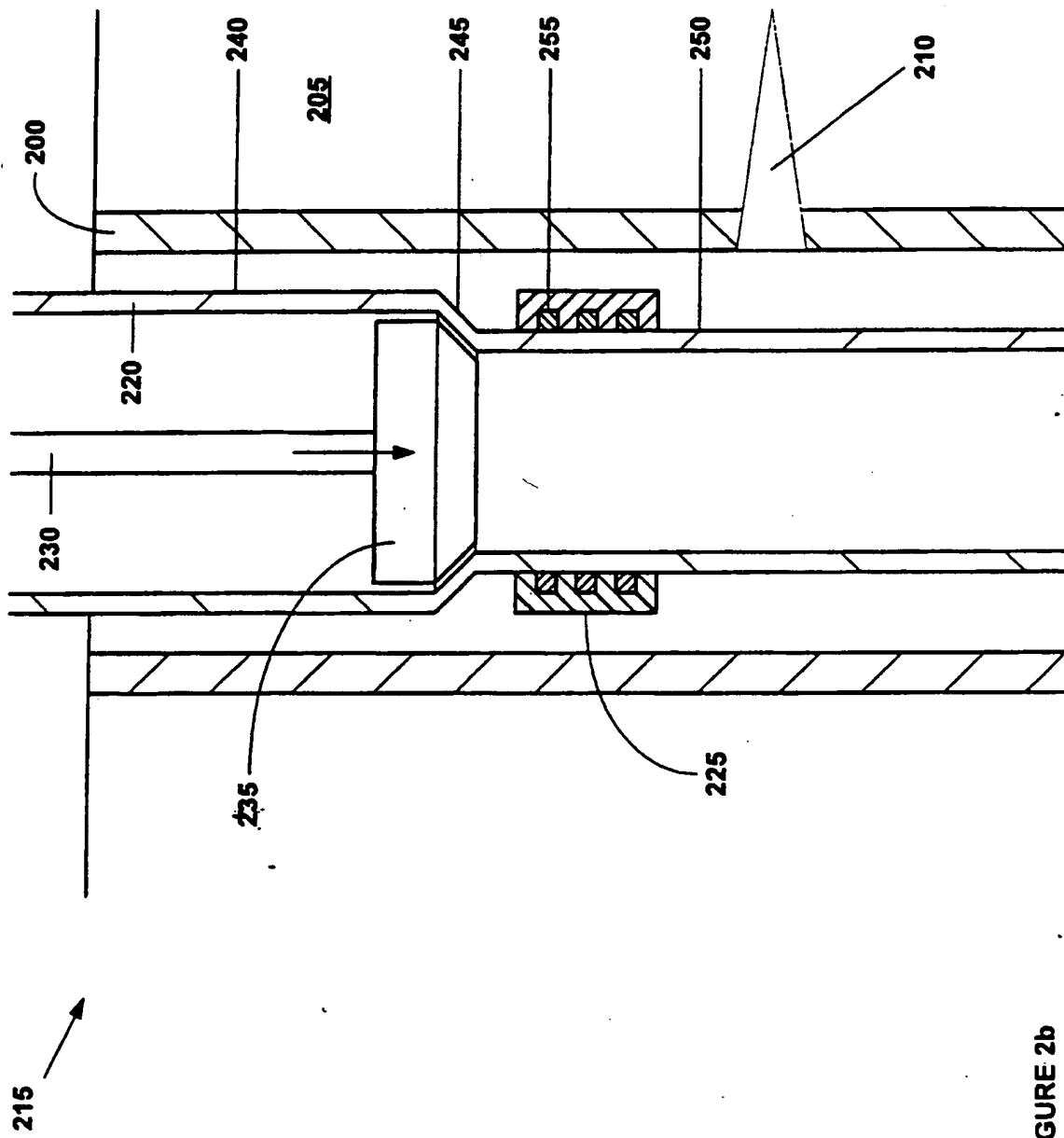


FIGURE 2a



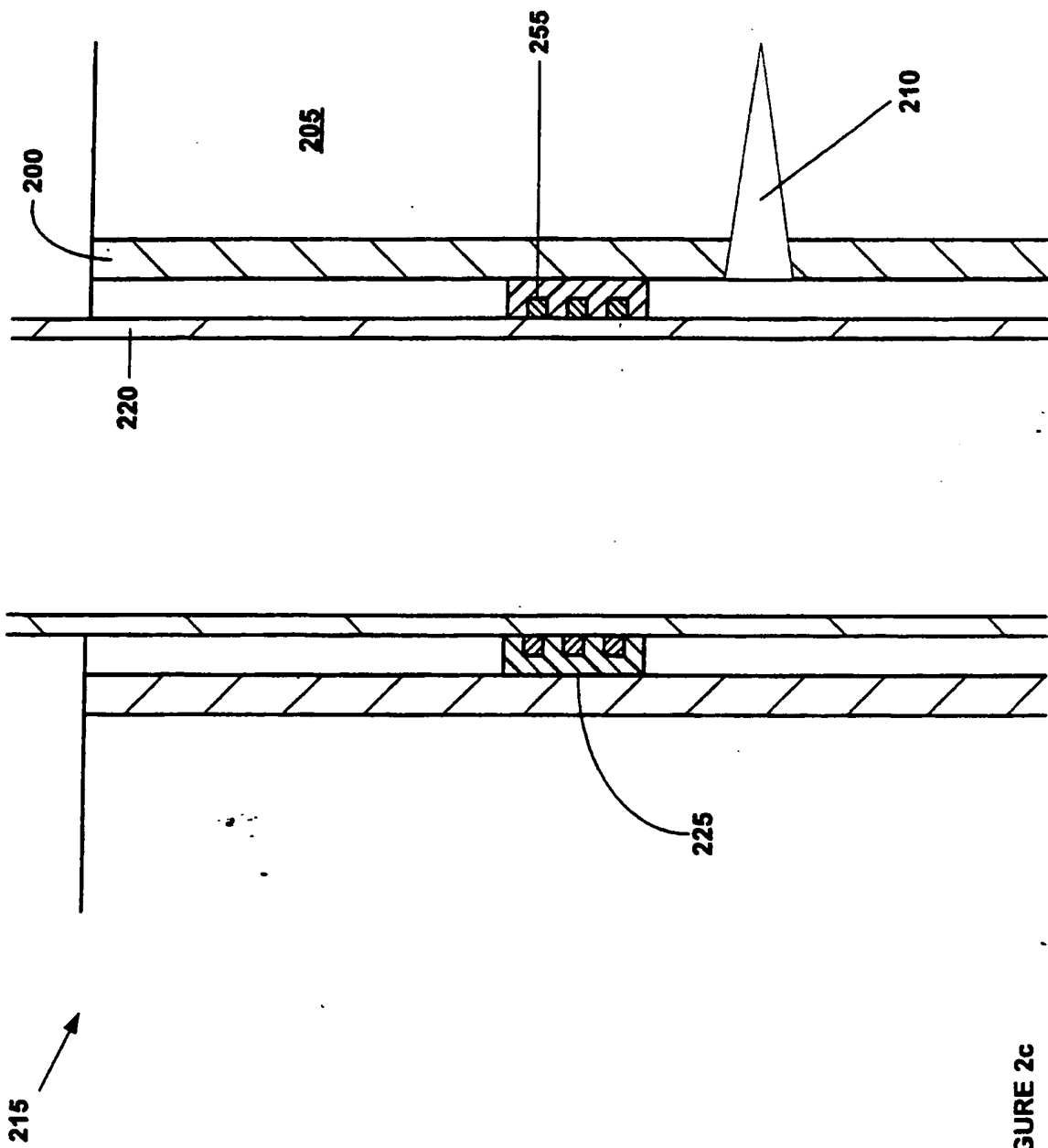


FIGURE 2c

## APPARATUS AND METHOD FOR ISOLATION OF SUBTERRANEAN ZONES

### Background of the Invention

This invention relates generally to oil and gas exploration, and in particular to  
5 isolating certain subterranean zones to facilitate oil and gas exploration.

During oil exploration, a wellbore typically traverses a number of zones within a subterranean formation. Some of these subterranean zones will produce oil and gas, while others will not. Further, it is often necessary to isolate subterranean zones from one another in order to facilitate the exploration for and production of oil and gas.  
10 Existing methods for isolating subterranean production zones in order to facilitate the exploration for and production of oil and gas are complex and expensive.

The present invention is directed to overcoming one or more of the limitations of the existing processes for isolating subterranean zones during oil and gas exploration.

### Summary of the Invention

15 According to a first aspect of the present invention there is provided an apparatus, comprising:

a packer positioned within a tubular apparatus including:

a radially expanded tubular member; and

one or more sealing members coupled to the outer surface of the radially  
20 expanded tubular member to provide a sealing mechanism between the tubular apparatus and the radially expanded tubular member.

Preferably, the tubular apparatus further comprises:

one or more solid tubular members, each solid tubular member including one or more external seals;

25 one or more perforated tubular members coupled to the solid tubular members;

a shoe coupled to one of the perforated tubular members; and

one or more intermediate solid tubular members coupled to and interleaved among the perforated tubular members, each intermediate solid tubular member including one or more external seals, the packer positioned within one or more of the  
30 solid, perforated, and intermediate tubular members.

Preferably, the apparatus further comprises one or more valve members.

Preferably, one or more of the intermediate solid tubular members include one or more valve members.

Preferably, the tubular apparatus further comprises one or more primary solid tubulars, each primary solid tubular including one or more external annular seals;  
n perforated tubulars coupled to the primary solid tubulars;  
n-1 intermediate solid tubulars coupled to and interleaved among the perforated  
5 tubulars, each intermediate solid tubular including one or more external annular seals;  
a shoe coupled to one of the perforated tubulars; and  
the packer positioned within one or more of the solid, perforated, and  
intermediate tubulars.

Preferably, the radially expanded tubular member comprises a radially expanded  
10 perforated tubular member.

Preferably, the radially expanded tubular member is adapted to be positioned  
within a wellbore casing.

Preferably, the apparatus further comprises a wellbore that traverses a  
subterranean formation;  
15 the tubular apparatus further comprising one or more solid tubular members  
positioned within the wellbore, each solid tubular member comprising one or more  
external seals that engage the wellbore;

an annulus defined between one or more of the solid tubular members and the  
wellbore;

20 the tubular apparatus further comprising one or more non-solid tubular members  
that permit fluidic materials to pass therethrough into the annulus coupled to the solid  
tubular members;

a shoe coupled to one of the non-solid tubular members,

the packer being positioned within one or more of the solid and non-solid tubular  
25 members.

Preferably, the apparatus further comprises a wellbore that traverses a  
subterranean formation;

the tubular apparatus further comprising one or more primary solid tubulars  
positioned within the wellbore, each primary solid tubular including one or more  
30 external annular seals that engage the wellbore;

an annulus defined between the primary solid tubulars and the wellbore;

the tubular apparatus further comprising n non-solid tubulars that permit fluidic  
materials to pass therethrough into the annulus coupled to the primary solid tubulars;

the tubular apparatus further comprising n-1 intermediate solid tubulars coupled to and interleaved among the non-solid tubulars, each intermediate solid tubular including one or more external annular seals that engage the wellbore;

a shoe coupled to one of the other tubulars,

5 the packer of being positioned within one or more of the solid and non-solid tubulars.

There is also provided a method of isolating a first subterranean zone from a second subterranean zone in a wellbore, comprising:

10 positioning one or more primary solid tubulars within the wellbore, the primary solid tubulars traversing the first subterranean zone;

positioning one or more secondary tubulars within the wellbore, the secondary tubulars traversing the second subterranean zone;

fluidicly coupling the secondary tubulars and the solid tubulars;

15 preventing the passage of fluids from the first subterranean zone to the second subterranean zone within the wellbore external to the solid and secondary tubulars; and

fluidicly isolating one or more annular regions within one or more of the tubulars using the apparatus according to the first aspect of the invention,

20 wherein the secondary tubulars permit fluidic material to pass therethrough in a radial direction.

There is also provided a method of extracting materials from a producing subterranean zone in a wellbore, at least a portion of the wellbore including a casing, comprising;

25 positioning one or more primary solid tubulars within the wellbore;

fluidicly coupling the primary solid tubulars with the casing;

positioning one or more secondary tubulars within the wellbore, the secondary tubulars traversing the producing subterranean zone;

fluidicly coupling the secondary tubulars with the solid tubulars;

30 fluidicly isolating the producing subterranean zone from at least one other subterranean zone within the wellbore;

fluidicly coupling at least one of the secondary tubulars with the producing subterranean zone; and

fluidicly isolating one or more annular regions within one or more of the tubulars using the apparatus according to the first aspect of the invention,



wherein the secondary tubulars permit fluidic materials to pass therethrough in a radial direction.

The method further comprises controllably fluidicly decoupling at least one of the secondary tubulars from at least one other of the secondary tubulars.

5       There is also provided a method of isolating a first subterranean zone from a second subterranean zone in a wellbore, comprising:

          positioning one or more primary solid tubulars within the wellbore, the primary solid tubulars traversing the first subterranean zone;

          defining an annulus between the primary solid tubulars and the wellbore;

10       positioning one or more non-solid tubulars within the wellbore that permit fluidic materials to pass therethrough into the annulus, the non-solid tubulars traversing the second subterranean zone;

          fluidicly coupling the solid and non-solid tubulars;

          preventing the passage of fluids from the first subterranean zone to the second subterranean zone within the wellbore external to the solid and other tubulars; and  
15       fluidicly isolating one or more annular regions within one or more of the tubulars using the apparatus according to the first aspect of the invention.

          There is also provided method of extracting materials from a producing subterranean zone in a wellbore, at least a portion of the wellbore including a casing,  
20       comprising;

          positioning one or more primary solid tubulars within the wellbore;

          fluidicly coupling the primary solid tubulars with the casing;

          defining an annulus between the solid tubulars and the wellbore;

          positioning one or more non-solid tubulars within the wellbore that permit fluidic  
25       materials to pass therethrough into the annulus, the non-solid tubulars traversing the producing subterranean zone;

          fluidicly coupling the non-solid tubulars with the solid tubulars;

          fluidicly isolating the producing subterranean zone from at least one other subterranean zone within the wellbore;

30       fluidicly coupling at least one of the non-solid tubulars with the producing subterranean zone; and

          fluidicly isolating one or more annular regions within one or more of the tubulars using the apparatus according to the first aspect of the invention.

### **Brief Description of the Drawings**

The invention will now be described by way of example with reference to the accompanying drawings, in which:

FIG. 1 is a fragmentary cross-sectional view illustrating the isolation of  
5 subterranean zones.

FIG. 2a is a fragmentary cross-sectional illustration of an embodiment of an apparatus for fluidically isolating annular regions within a wellbore casing.

FIG. 2b is a fragmentary cross-sectional illustration of the apparatus of FIG. 2a after initiating the axial displacement of the expansion cone.

10 FIG. 2c is a fragmentary cross-sectional illustration of the apparatus of FIG. 2b after completion of the radial expansion process.

### **Detailed Description of the Illustrative Embodiments**

An apparatus and method for isolating one or more subterranean zones from one or more other subterranean zones is provided. The apparatus and method permits  
15 a producing zone to be isolated from a nonproducing zone using a combination of solid and slotted tubulars. In the production mode, the teachings of the present disclosure may be used in combination with conventional, well known, production completion equipment and methods using a series of packers, solid tubing, perforated tubing, and sliding sleeves, which will be inserted into the disclosed apparatus to permit the  
20 commingling and/or isolation of the subterranean zones from each other.

An apparatus and method for providing a packer for use in isolating one or more subterranean zones from one or more subterranean zones is also provided. The apparatus and method permit a packer to be provided by radially expanding a tubular member including one or more outer sealing members into engagement with a  
25 preexisting tubular structure.

Referring to Fig. 1, a wellbore 105 including a casing 110 is positioned in a subterranean formation 115. The subterranean formation 115 includes a number of productive and non-productive zones, including a water zone 120 and a targeted oil sand zone 125. During exploration of the subterranean formation 115, the wellbore 105 may be extended in a well known manner to traverse the various productive and non-productive zones, including the water zone 120 and the targeted oil sand zone 125.

In order to fluidically isolate the water zone 120 from the targeted oil sand zone 125, an apparatus 130 is provided that includes one or more sections of solid casing 135, one or more external seals 140, one or more sections of slotted casing 145, one or more intermediate sections of solid casing 150, and a solid shoe 155.

The solid casing 135 provides a fluid conduit that transmits fluids and other materials from one end of the solid casing 135 to the other end of the solid casing 135. The solid casing 135 may comprise any number of conventional commercially available sections of solid tubular casing such as, for example, oilfield tubulars fabricated from chromium steel or fiberglass. The solid casing 135 comprises oilfield tubulars available from various foreign and domestic steel mills.

The solid casing 135 is coupled to the casing 110. The solid casing 135 may be coupled to the casing 110 using any number of conventional commercially available processes such as, for example, welding, slotted and expandable connectors, or expandable solid connectors. In a preferred embodiment, the solid casing 135 is coupled to the casing 110 by using expandable solid connectors. The solid casing 135 may comprise a plurality of such solid casing 135.

The solid casing 135 is coupled to one more of the slotted casings 145. The solid casing 135 may be coupled to the slotted casing 145 using any number of conventional commercially available processes such as, for example, welding, or slotted and expandable connectors. In a preferred embodiment, the solid casing 135 is coupled to the slotted casing 145 by expandable solid connectors.

The casing 135 includes one more valve members 160 for controlling the flow of fluids and other materials within the interior region of the casing 135. Alternatively, during the production mode of operation, an internal tubular string with various arrangements of packers, perforated tubing, sliding sleeves, and valves may be employed within the apparatus to provide various options for commingling and isolating subterranean zones from each other while providing a fluid path to the surface.

The casing 135 is placed into the wellbore 105 by expanding the casing 135 in the radial direction into intimate contact with the interior walls of the wellbore 105. The casing 135 may be expanded in the radial direction using any number of conventional commercially available methods.

5        The seals 140 prevent the passage of fluids and other materials within the annular region 165 between the solid casings 135 and 150 and the wellbore 105. The seals 140 may comprise any number of conventional commercially available sealing materials suitable for sealing a casing in a wellbore such as, for example, lead, rubber or epoxy. In a preferred embodiment, the seals 140 comprise Stratalok epoxy material  
10        available from Halliburton Energy Services.

      The slotted casing 145 permits fluids and other materials to pass into and out of the interior of the slotted casing 145 from and to the annular region 165. In this manner, oil and gas may be produced from a producing subterranean zone within a subterranean formation. The slotted casing 145 may comprise any number of  
15        conventional commercially available sections of slotted tubular casing. Preferably, the slotted casing 145 comprises expandable slotted tubular casing available from Petrolite in Aberdeen, Scotland. Most preferably, the slotted casing 145 comprises expandable slotted sandscreen tubular casing available from Petrolite in Aberdeen, Scotland.

20        The slotted casing 145 is coupled to one or more solid casing 135. The slotted casing 145 may be coupled to the solid casing 135 using any number of conventional commercially available processes such as, for example, welding, or slotted or solid expandable connectors. Preferably, the slotted casing 145 is coupled to the solid casing 135 by expandable solid connectors.

25        The slotted casing 145 is coupled to one or more intermediate solid casings 150. The slotted casing 145 may be coupled to the intermediate solid casing 150 using any number of conventional commercially available processes such as, for example, welding or expandable solid or slotted connectors. Preferably, the slotted casing 145 is coupled to the intermediate solid casing 150 by expandable solid connectors.

30        The last slotted casing 145 is coupled to the shoe 155. The last slotted casing 145 may be coupled to the shoe 155 using any number of conventional commercially available processes such as, for example, welding or expandable solid or slotted connectors. Preferably, the last slotted casing 145 is coupled to the shoe 155 by an expandable solid connector.

In an alternative embodiment, the shoe 155 is coupled directly to the last one of the intermediate solid casings 150.

The slotted casings 145 are positioned within the wellbore 105 by expanding the slotted casings 145 in a radial direction into intimate contact with the interior walls of the wellbore 105. The slotted casings 145 may be expanded in a radial direction using any number of conventional commercially available processes.

The intermediate solid casing 150 permits fluids and other materials to pass between adjacent slotted casings 145. The intermediate solid casing 150 may comprise any number of conventional commercially available sections of solid tubular casing such as, for example, oilfield tubulars fabricated from chromium steel or fiberglass. The intermediate solid casing 150 comprises oilfield tubulars available from foreign and domestic steel mills.

The intermediate solid casing 150 is coupled to one or more sections of the slotted casing 145. The intermediate solid casing 150 may be coupled to the slotted casing 145 using any number of conventional commercially available processes such as, for example, welding, or solid or slotted expandable connectors. Preferably, the intermediate solid casing 150 is coupled to the slotted casing 145 by expandable solid connectors. The intermediate solid casing 150 may comprise a plurality of such intermediate solid casing 150.

Each intermediate solid casing 150 includes one or more valve members 170 for controlling the flow of fluids and other materials within the interior region of the intermediate casing 150. In an alternative embodiment, as will be recognized by persons having ordinary skill in the art and the benefit of the present disclosure, during the production mode of operation, an internal tubular string with various arrangements of packers, perforated tubing, sliding sleeves, and valves may be employed within the apparatus to provide various options for commingling and isolating subterranean zones from each other while providing a fluid path to the surface.

The intermediate casing 150 is placed into the wellbore 105 by expanding the intermediate casing 150 in the radial direction into intimate contact with the interior walls of the wellbore 105. The intermediate casing 150 may be expanded in the radial direction using any number of conventional commercially available methods.

One or more of the intermediate solid casings 150 may be omitted. One or more of the slotted casings 145 are provided with one or more seals 140.

The shoe 155 provides a support member for the apparatus 130. In this manner, various production and exploration tools may be supported by the shoe 150. The shoe 150 may comprise any number of conventional commercially available shoes suitable for use in a wellbore such as, for example, cement filled shoe, or an aluminum or  
5 composite shoe. Preferably, the shoe 150 comprises an aluminum shoe available from Halliburton. The shoe 155 is selected to provide sufficient strength in compression and tension to permit the use of high capacity production and exploration tools.

The apparatus 130 includes a plurality of solid casings 135, a plurality of seals 140, a plurality of slotted casings 145, a plurality of intermediate solid casings 150, and  
10 a shoe 155. More generally, the apparatus 130 may comprise one or more solid casings 135, each with one or more valve members 160, n slotted casings 145, n-1 intermediate solid casings 150, each with one or more valve members 170, and a shoe 155.

During operation of the apparatus 130, oil and gas may be controllably produced  
15 from the targeted oil sand zone 125 using the slotted casings 145. The oil and gas may then be transported to a surface location using the solid casing 135. The use of intermediate solid casings 150 with valve members 170 permits isolated sections of the zone 125 to be selectively isolated for production. The seals 140 permit the zone 125 to be fluidically isolated from the zone 120. The seals 140 further permits isolated  
20 sections of the zone 125 to be fluidically isolated from each other. In this manner, the apparatus 130 permits unwanted and/or non-productive subterranean zones to be fluidically isolated.

As will be recognized by persons having ordinary skill in the art and also having the benefit of the present disclosure, during the production mode of operation, an  
25 internal tubular string with various arrangements of packers, perforated tubing, sliding sleeves, and valves may be employed within the apparatus to provide various options for commingling and isolating subterranean zones from each other while providing a fluid path to the surface.

Referring to FIGS. 2a, 2b, and 2c, a preferred embodiment of a method and  
30 apparatus for fluidically isolating a section of a wellbore casing will be described. Referring to Fig. 2a, a wellbore casing 200 is positioned within a subterranean formation 205. The wellbore casing 200 may be positioned in any orientation from the vertical direction to the horizontal direction. The wellbore casing 200 further includes one or more openings 210 that may have been, for example, the result of: (1)